Announcements

- FINAL EXAM:
  - PHYS 132-001: Wednesday, May 10 @ 10-11:50 am
- Homework for tomorrow…

  Ch. 23, Probs. 26, 27, 32 & 33

  23.14: 22°
  23.16: 23 cm
  23.18: 113 cm
  23.53: 1.1°
- Office hours…

  MW 10-11 am
  TR 9-10 am
  F 12-1 pm
- Tutorial Learning Center (TLC) hours:

  MTWR 8-6 pm
  F 8-11 am, 2-5 pm
  Su 1-5 pm

Chapter 23

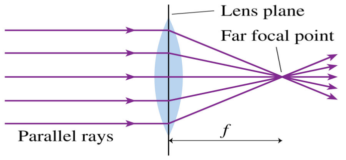
Ray Optics

(Thin Lenses: Ray Tracing & Refraction Theory)

Last time…

- *Rayleigh Scattering…*

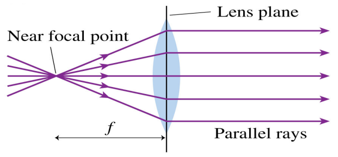
$$I_{scattered} \propto \frac{1}{\lambda^4}$$



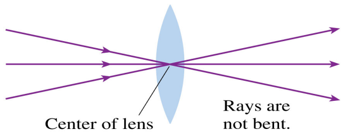
Any ray initially parallel to the optical axis will refract through the focal point on the far side of the lens.

Ray Tracing through a thin *converging lens*…

1. A *parallel ray* will go through the *far focal point* after passing through the lens.
2. A ray through the *near focal point* of a thin lens becomes *parallel* after passing through the lens.
3. A ray through the *center* of a thin lens travels in a *straight line*.



Any ray passing through the near focal point emerges from the lens parallel to the optical axis.



Any ray directed at the center of the lens passes through in a straight line.

i.e. 23.8
Finding the image of a flower

A 4.0 cm diameter flower is 200 cm from the 50 cm focal length lens of a camera.

How far should the light detector be placed behind the lens to record a well-focused image?

What is the diameter of the image on the detector?

Lateral Magnification…

- The image can be either *larger* or *smaller* than the object, depending on the location and focal length of the lens.
- The *lateral magnification, m,* is defined as:

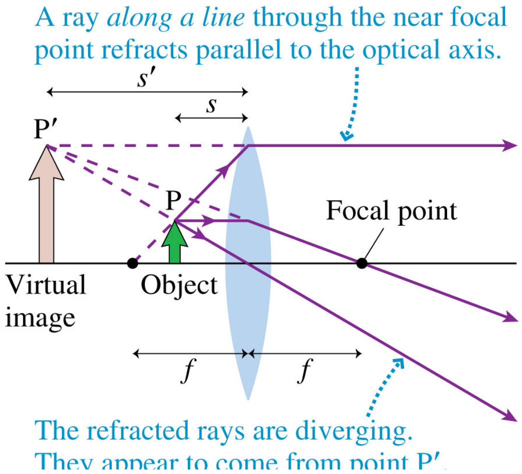
$$\boxed{m = -\frac{s'}{s}}$$

Notice:

- *Positive m* = *upright* image.
- *Negative m* = *inverted* image.
- The absolute value of *m* gives the size ratio of the image and object: $h'/h = |m|$.

Virtual Images…

- Consider a *converging lens* for which the object is *inside* the focal point, at distance $s < f$.
- All 3 rays appear to *diverge* from point P'.
- Point P' is an *upright*, *virtual image* of the object point P.



(b)

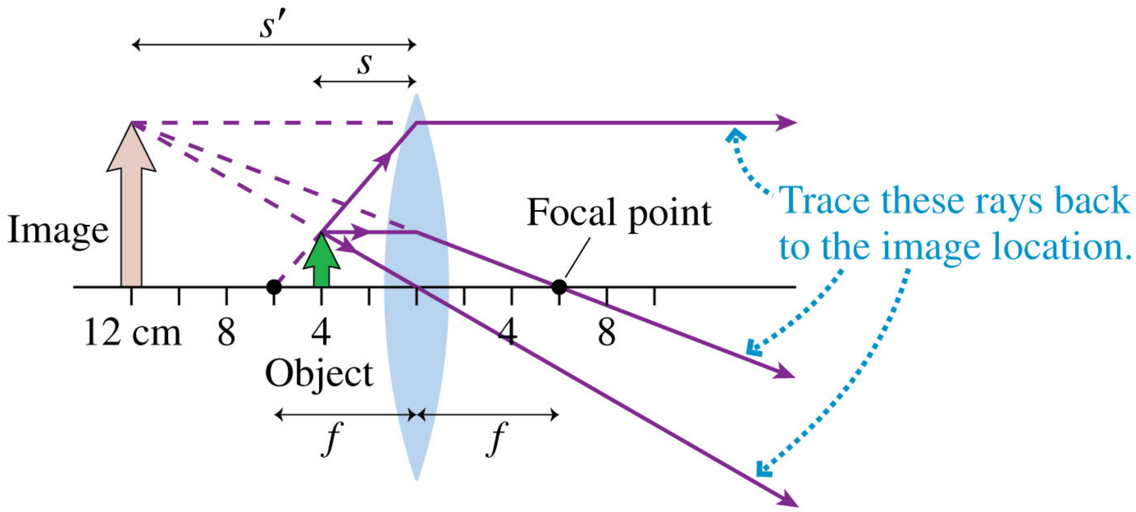
Notice:

- Image distance s' for a *virtual image* is *negative*.

i.e. 23.9: *Magnifying a flower*

To see a flower better, a naturalist holds a 6.0 cm focal length magnifying glass 4.0 cm from the flower.

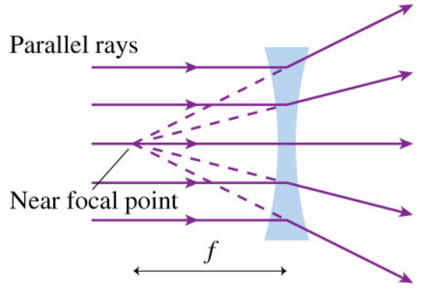
What is the magnification?



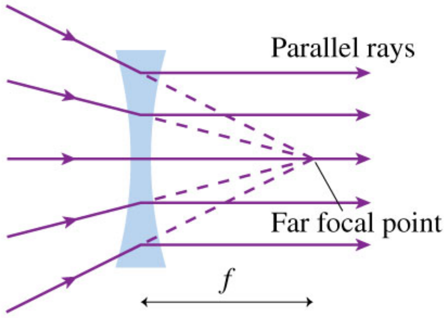
23.6
Thin Lenses: Ray Tracing

3 situations form the basis for ray tracing through a thin *diverging lens***.**

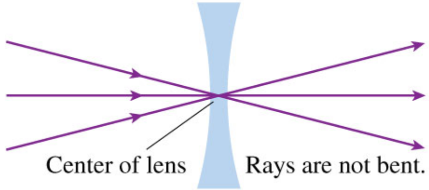
1. A ray initially *parallel* to the optical axis will appear to diverge from the *near focal point* after passing through the lens.
2. A ray directed along a line toward the *far focal point* becomes *parallel* to the optical axis after passing through the lens.
3. A ray through the *center* of a thin lens is neither bent nor displaced but travels in a *straight line*.



Any ray initially parallel to the optical axis diverges along a line through the near focal point.



Any ray directed along a line toward the far focal point emerges from the lens parallel to the optical axis.



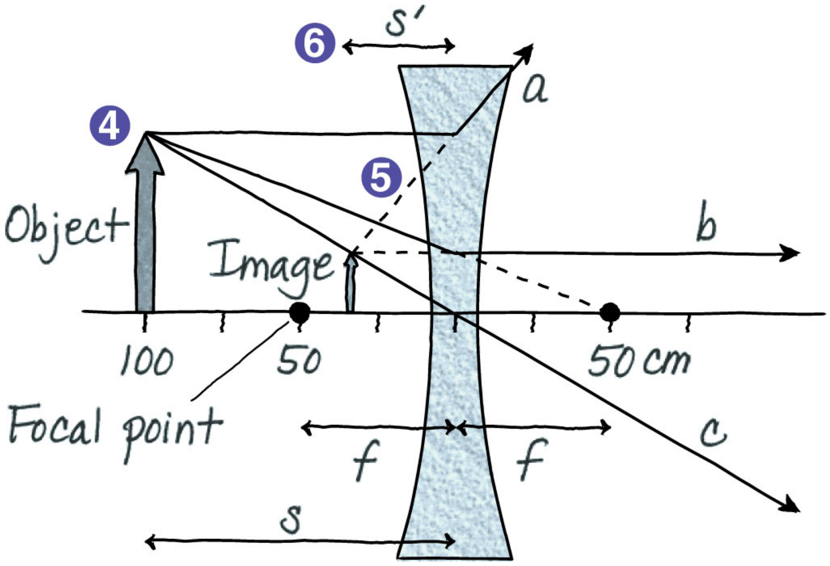
Any ray directed at the center of the lens passes through in a straight line.

i.e. 23.10
Minify-ing a flower

A diverging lens with a focal length of 50 cm is placed 100 cm from a flower.

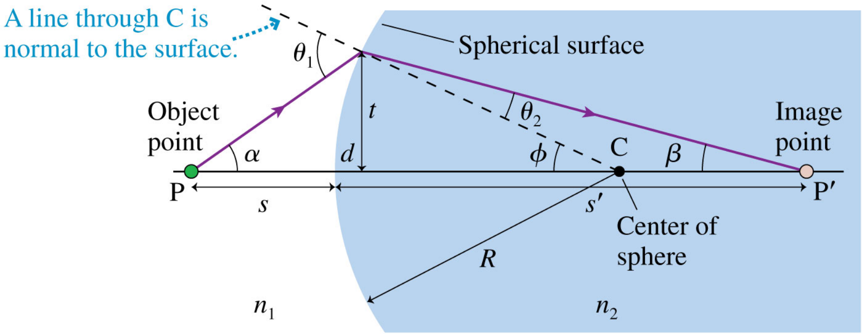
Where is the image?

What is its magnification?



23.7:
Thin Lenses: Refraction Theory

- Consider a spherical boundary between two transparent media with indices of refraction n_1 and n_2.
- The sphere has radius of curvature R and is centered at pt C.



If an object is located at distance s from a *spherical refracting surface*, an image will be formed at distance s' given by:

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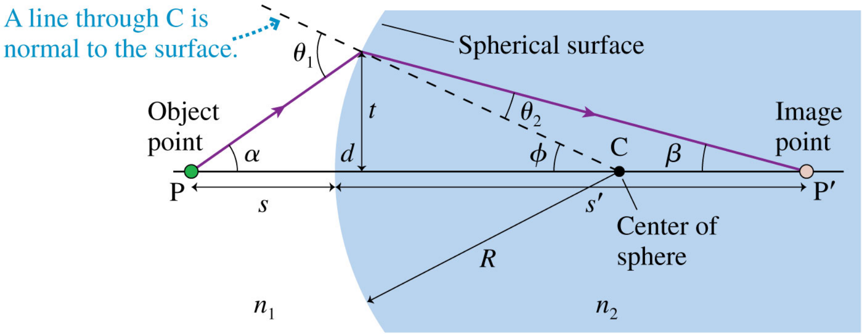

If an object is located at distance s from a *spherical refracting surface*, an image will be formed at distance s' given by:

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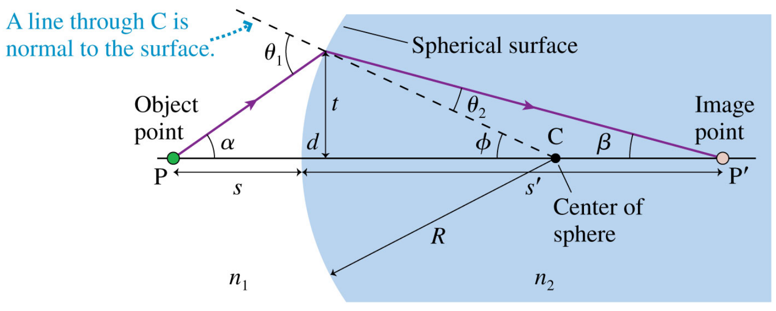


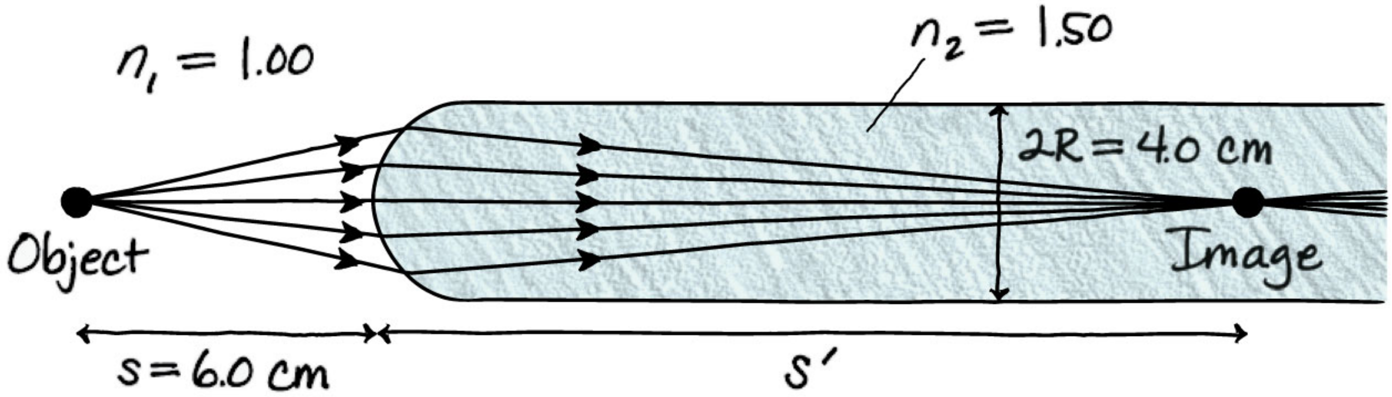
TABLE 23.3 Sign convention for refracting surfaces

	Positive	Negative
R	Convex toward the object	Concave toward the object
s'	Real image, opposite side from object	Virtual image, same side as object

i.e. 23.11: Image formation inside a glass rod

One end of a 4.0 cm diameter glass rod is shaped like a hemisphere. A small light bulb is 6.0 cm from the end of the rod.

Where is the bulb's image located?



i.e. 23.12:
A goldfish in a bowl

A goldfish lives in a spherical fish bowl 50 cm in diameter. If the fish is 10 cm from the near edge of the bowl, where does the fish appear when viewed from the outside?

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